

Designing Teaching Laboratories and their comparison with Research Laboratories



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Teaching Laboratories

Mission

- Education and Exploration through Empirical Method
- Project Centered Experiments
- Discipline Related Experiments

In-Lab Interaction

- Between Professor and student
- Between Professor and groups of students
- Between Professor and the entire lab section



Research Laboratories

Mission

- Scientific Discovery is a Result of Multidisciplinary Research



Teaching Laboratories

Program

Historically

- Serve single Disciplinary purpose
- One or Only a few courses
- Space Utilization is low

Lately

- Need for Flexibility
- Increased Utilities
- Emphasis on Undergraduate Research
- Space planning on a Research Module
- Used as Research Lab during breaks



Research Laboratories

Program

Usually

- Serve Single Disciplinary Purpose
- Need for Flexibility
- Designed based on Generic Module
- Assigned to Research Teams in Modular increments based on funding
- Space Utilization is very high



Teaching Laboratories

Occupancy

- Depends on Discipline
- Depends on Level and Type of Higher Education
- 12 to 24 Students per Professor
- 50 to 85 square feet per Student

Organic
Chemistry
Lab



General
Chemistry
Lab

Research Laboratories

Occupancy

- Depends on Discipline and Institution
- Depends on Level and Type of Research
- 4 to 12 researchers per Principal Investigator
- 80 to 130 square feet per researcher



Teaching Laboratories

Time of Use

- Fixed Schedule of Use
- 3 to 4 hour time slots
- Minimum 3 afternoons per week per semester or
- Maximum 5 to 6 mornings and afternoons per week



Research Laboratories

Time of Use

- Depends on Institution
- Depends on Level and Type of Research
- 10 to 20 hours per day



Teaching Laboratories

Space Relationships

- Immediate adjacency to Prep Room that can be shared between labs.
- Nearby Classroom for lecture, pre-lab and post-lab discussion
- Professor's office space is usually near research component
- Work table doubles as writing area



Research Laboratories

Space Relationships

- Contiguity of Research Modules is important for flexibility
- Dedicated or shared, equipment and support rooms
- Writing space either within the lab or immediately outside
- Principal Investigator offices are usually clustered, either adjacent to the lab, across the hallway or on a different floor



Teaching Laboratories

Risks and Safety Measures

- Greatest risk out of inexperience in lab protocol
- Experimental Demonstrations in a fume hood
- Visibility across lab
- Provision of emergency showers, eye washes, spill kits, fire extinguishers, etc.
- Use of computers for Experimental Demonstrations



Research Laboratories

Risks and Safety Measures

- Physical Hazards can be very high due to use of toxic chemicals, radioactive material, bio-containment etc.
- Safety measures are similar to teaching lab but emphasis on visibility is not as great
- Reagent shelves and apparatus racks on islands for set ups
- Fume hoods on islands, due to need for large numbers results in less visibility



Teaching Laboratories

Furnishings

- Fixed or Mobile Student Benches
- Low or No Reagent Shelving
- Shared Bench for Instruments, Displays or Distribution
- Dedicated Storage for Student Apparatus
- Storage for Book Bags and Coats
- Writing Board
- Projection Screen
- Demo Table



Research Laboratories

Furnishings

- Fixed or Movable Benches with floor supported or suspended casework including reagent racks
- Accommodate changes within research project, research groups, and changes over time



Teaching Laboratories

Equipment

- Most Equipment located in Shared Equipment Rooms
- Audio Visual Equipment in the Storage Rooms
- Computers, Electronic White Boards in Lab



Research Laboratories

Equipment

- Refrigerators and Incubators located in support zones within the lab
- Other pieces in Dedicated and/or Shared Equipment Rooms



Teaching Laboratories

Fume Hoods

- Chemistry Instruction:
1 student per 4' fume hood or
2 students per 6' fume hood.
Five 6' to eighteen 4' fume hoods
Dispensing and Demonstration
fume hoods
- Other disciplines:
1 to 2 fume hoods per lab for
limited hazard material use
- Flexible Arm Local Exhaust



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Research Laboratories

Fume Hoods

- Quantity and Size depend on Nature of Research
- Two to Six per Lab Module depending on Discipline of Research



Teaching Laboratories

Fume Hood Use

- Cleaned at end of each session for next section to set up
- Minimal Exhaust between actual Lab Sessions
- Dispensing Hoods always on



Research Laboratories

Fume Hood Use

- Research Fume Hoods are always operating
- Unoccupied or Night Time set-back on fan speed



Teaching Laboratories

Security Factor

- Locked before and after sessions
- Restricted access after hours
- Chemical Supply and Waste Rooms secured at all times



Photo Courtesy: Architectural Record

Research Laboratories

Security Factor

- Varies between Institution
- Open Inter-lab Circulation
- Per Floor Security or Whole Building Security
- Special Hazards



Teaching Laboratories

Services/Utilities

- Piped Compressed Air, Lab Vacuum, may be Nitrogen
- Distilled or RODI Water
- Power and Data
- Portable Gas Cylinders
- Supplied from below the floor for clear sightlines



Photo Courtesy
Architectural Record

Research Laboratories

Services/Utilities

- Piped Natural Gas, Compressed Air, Lab Vacuum, Nitrogen
- Special gases and liquefied (cryogenic) gases, either piped or in tanks, sometimes manifolded
- Distilled or RODI Water
- Power and Data
- Emergency Power and/or UPS
- Supplied from above within the lab for ease of customization



Teaching Laboratories

Current Trends and Future Direction

- Electronics are small, but electronic equipment can be huge



Teaching Laboratories

Current Trends and Future Direction

- Flexible Technology Labs

High Bay Spaces

Large Pieces of Equipment

Subsonic Wind Tunnels

Supersonic Shock Tube

20' to 30' Long



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Teaching Laboratories

Current Trends and Future Direction

- Technology Integrated
- Participation in Networked Information Society
- Problem-based, Not Didactic
- Integrative and Collaborative
- Small-group Interaction
- Real World Issues
- Undergraduate Research and Development



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Teaching Laboratories

Current Trends and Future Direction

- Multimedia, Interactive Conferencing and Presentation



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Teaching Laboratories

Current Trends and Future Direction

- Re-configurable Work Surfaces, Partitions, Wire Management and Mobile Computer Carts



Pathways System; Photo Courtesy: Steelcase

Freedom Desk; Photo Courtesy: desks4computers.com

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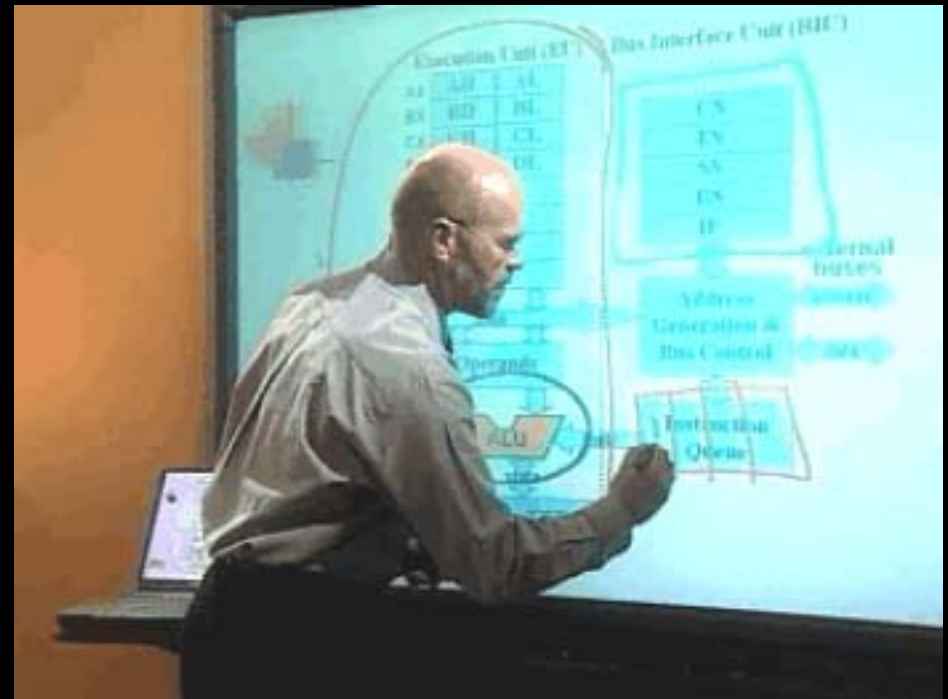
Teaching Laboratories

Current Trends and Future Direction

- Team Home Bases
- Brainstorming Center



Photo Courtesy: Stanford Interactive Workspaces Project



Teaching Laboratories

Current Trends and Future Direction

- CAD/Imaging Design Studios
- Virtual Reality Environments



Imaging Cav; Photo Courtesy: Center for Parallel Computers, KTH, PDC

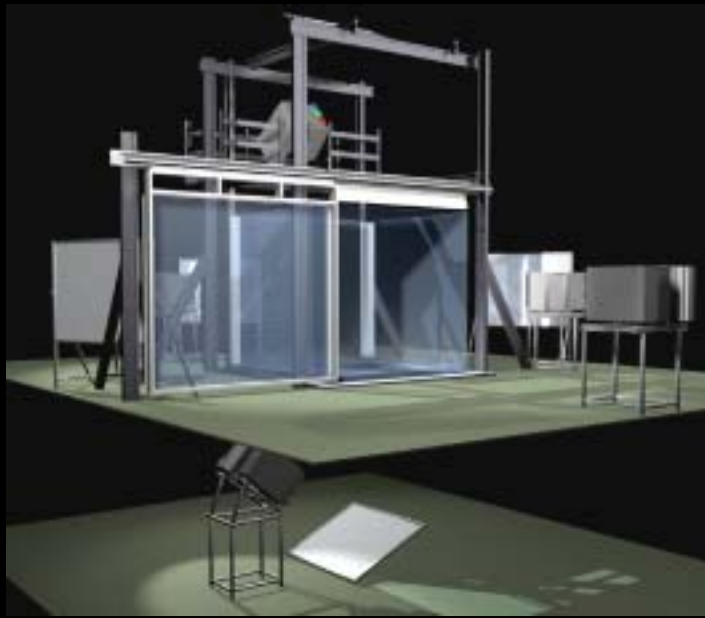


Wedgorama; Photo Courtesy: Australian National University

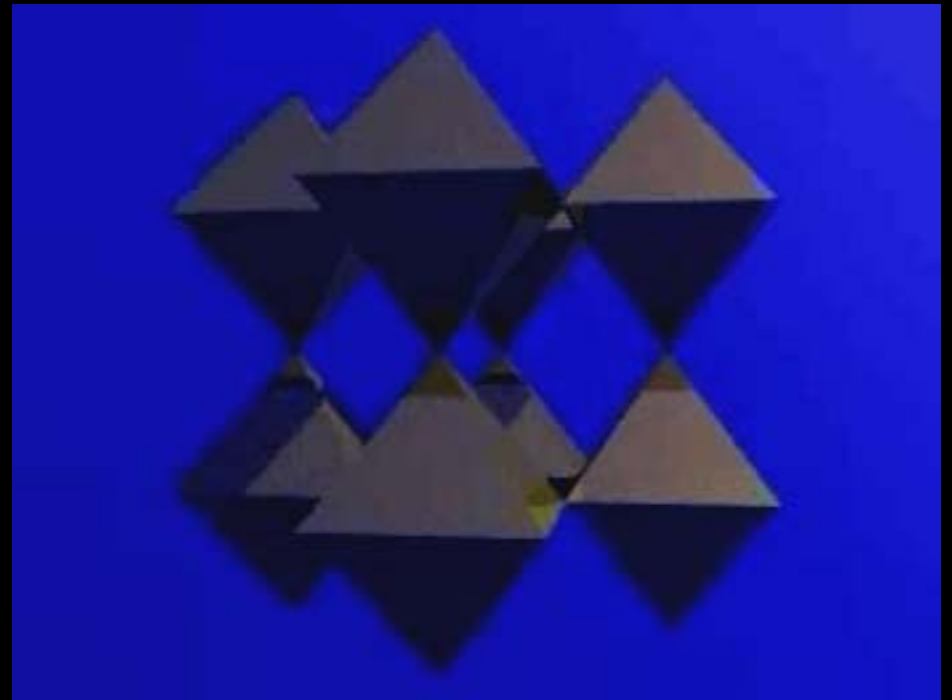
Teaching Laboratories

Current Trends and Future Direction

- Virtual Reality Imaging Cave
- Rapid Prototyping



Cubic I Space; Photo Courtesy: Barco Virtual and Augmented Reality



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